

Detector Stacking and Un-stacking **Cell Guides**

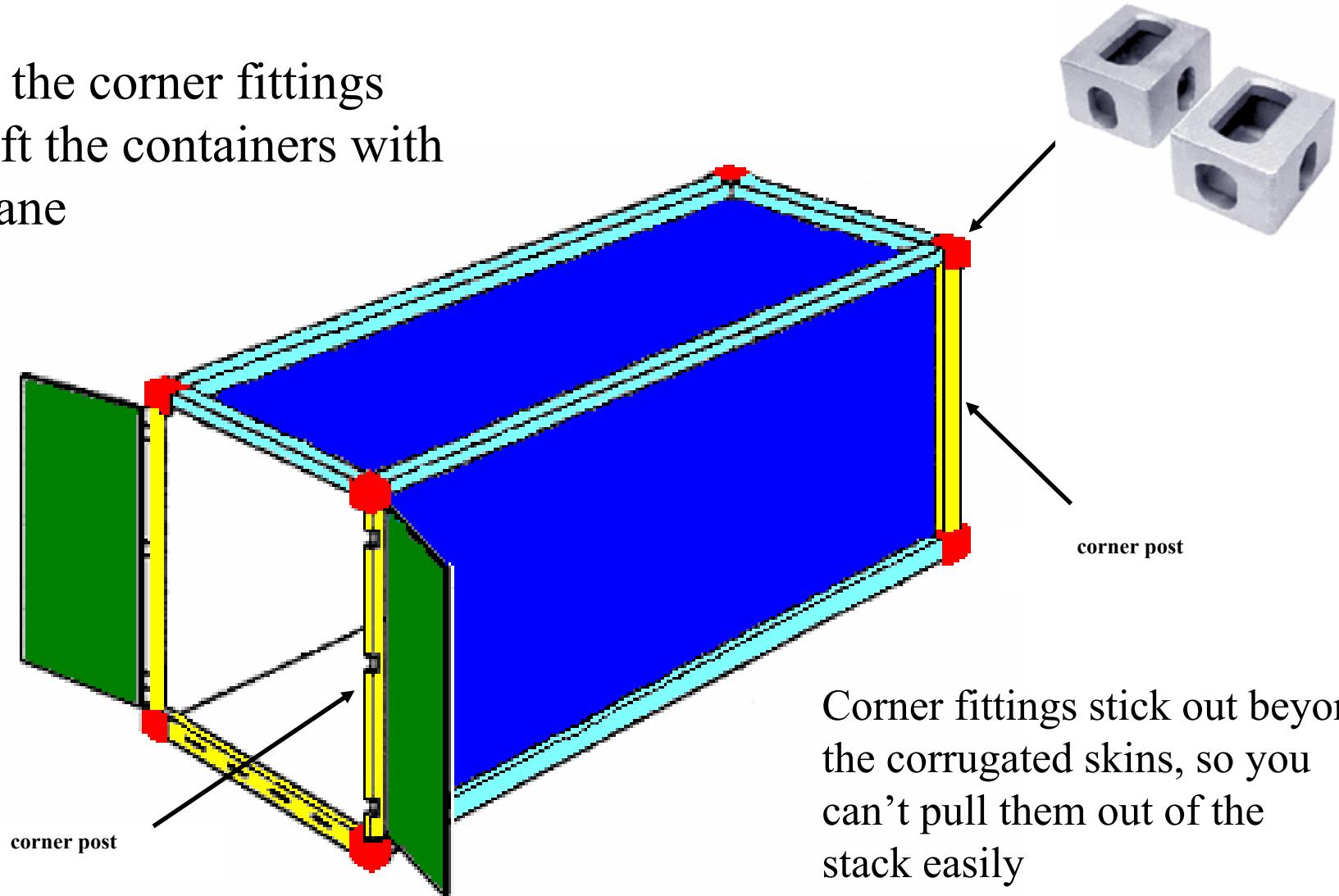
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2nd NuMI Off-Axis Experiment Detector Workshop
at Argonne National Laboratory

April 27, 2003

Remember what 20-foot
containers look like

Use the corner fittings
to lift the containers with
a crane



Since the SLAC workshop

- We have examined the corner posts of standard ISO 20-foot shipping containers and believe they can conservatively be stacked to 10 high when fully loaded – return to this later
- We have tried a couple of container modifications to allow access to all the detectors in the stack, but the mods do not seem cost effective
- How do we get at a detector deep in the stack?

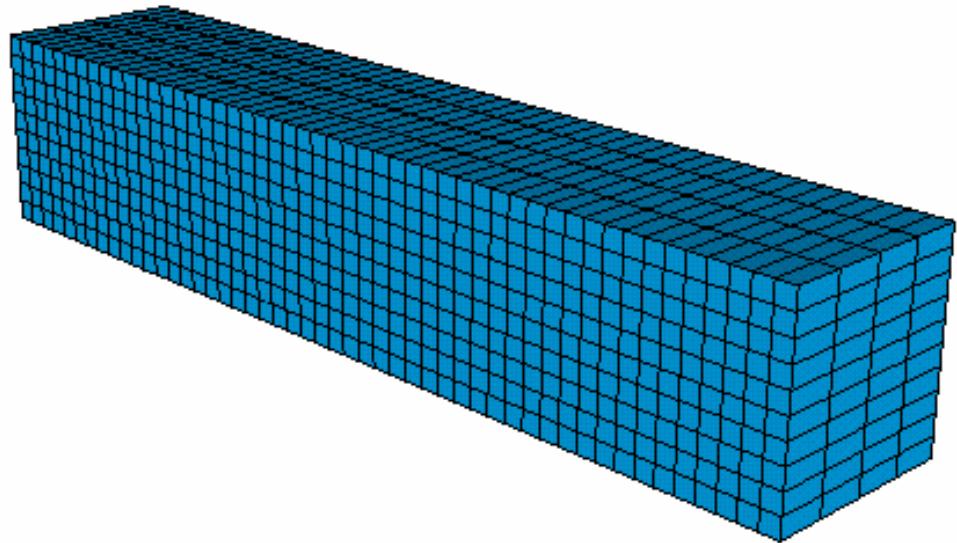


Figure 1. A 4x10x50 Container Array

Off-Axis notes will be posted next week

Some History

- These containers were invented in the mid 1950s by Malcom McLean, a North Carolina trucking owner who grew tired of wasting his trucking company's time with trucks standing idle in line as ships were unloaded bit by bit by dockworkers.
- McLean developed sealed truck trailers and the concept of loading and unloading the trailer interiors only at the points of origin and destination.
- **The first ship modified to accept these “containers” on deck, sailed with 58 of them from New York to Houston in April, 1956. This was the start of McLean’s company, the Sea-Land Corporation.**
- The Matson Line (Hawaii) put the first fully containerized ship into service in 1960.
- The International Standards Organization (ISO) first established container standards in 1961. The ISO standard is not prescriptive and instead simply stipulates tests that the containers must pass.

Just use them as they were designed to be used

- So this system of transportation has been around a very long time, allowing fifty years of engineering innovation and solution.
- Modern container ships have exactly our problem – when the ship arrives in port, the object is to unload the containers quickly to get them on to their final destination and to get the container ships back out to sea fully loaded heading for the next port.
- To accomplish this, container ships are equipped with steel skeletons called “cell guides” and there is an ISO standard for these guides
 - A special lifting fixture is used with remote actuators which engage the corner blocks on the top of the container.
 - A recent survey indicates that port crane operators can execute full crane cycles to remove and position containers at rates of between 30 and 60 boxes per hour.

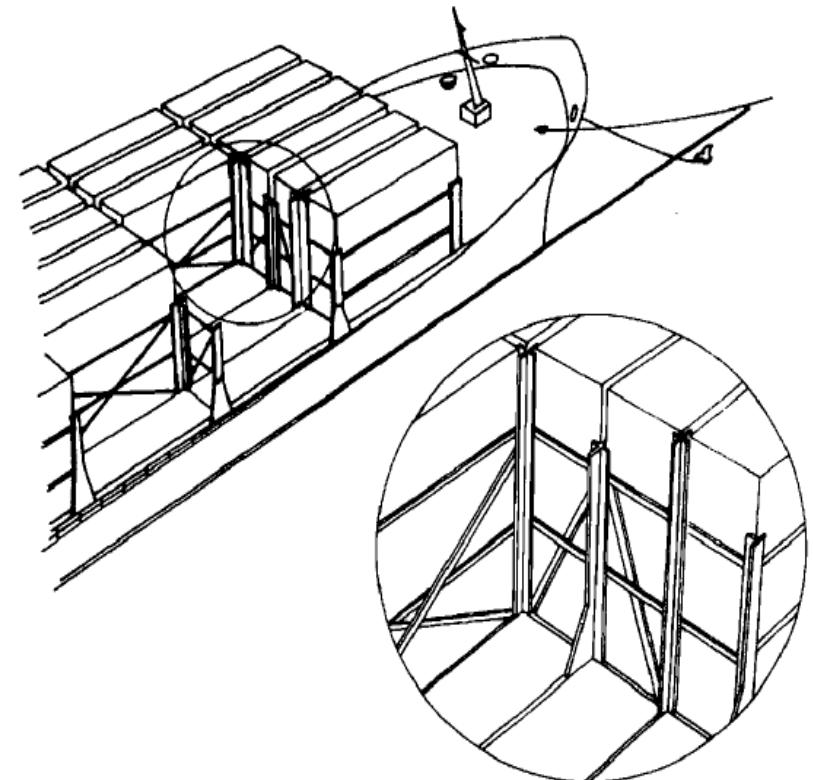


Figure 1. Container ship cell guides

Hatchless Cellular Vessels

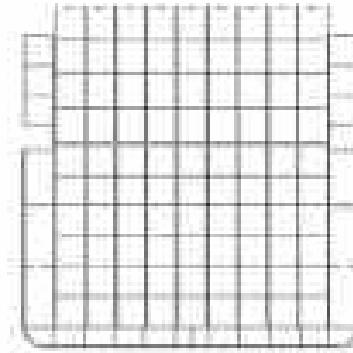
are what we need to copy



Like Feeder airlines to hubs
or fast hub-to-hub traffic

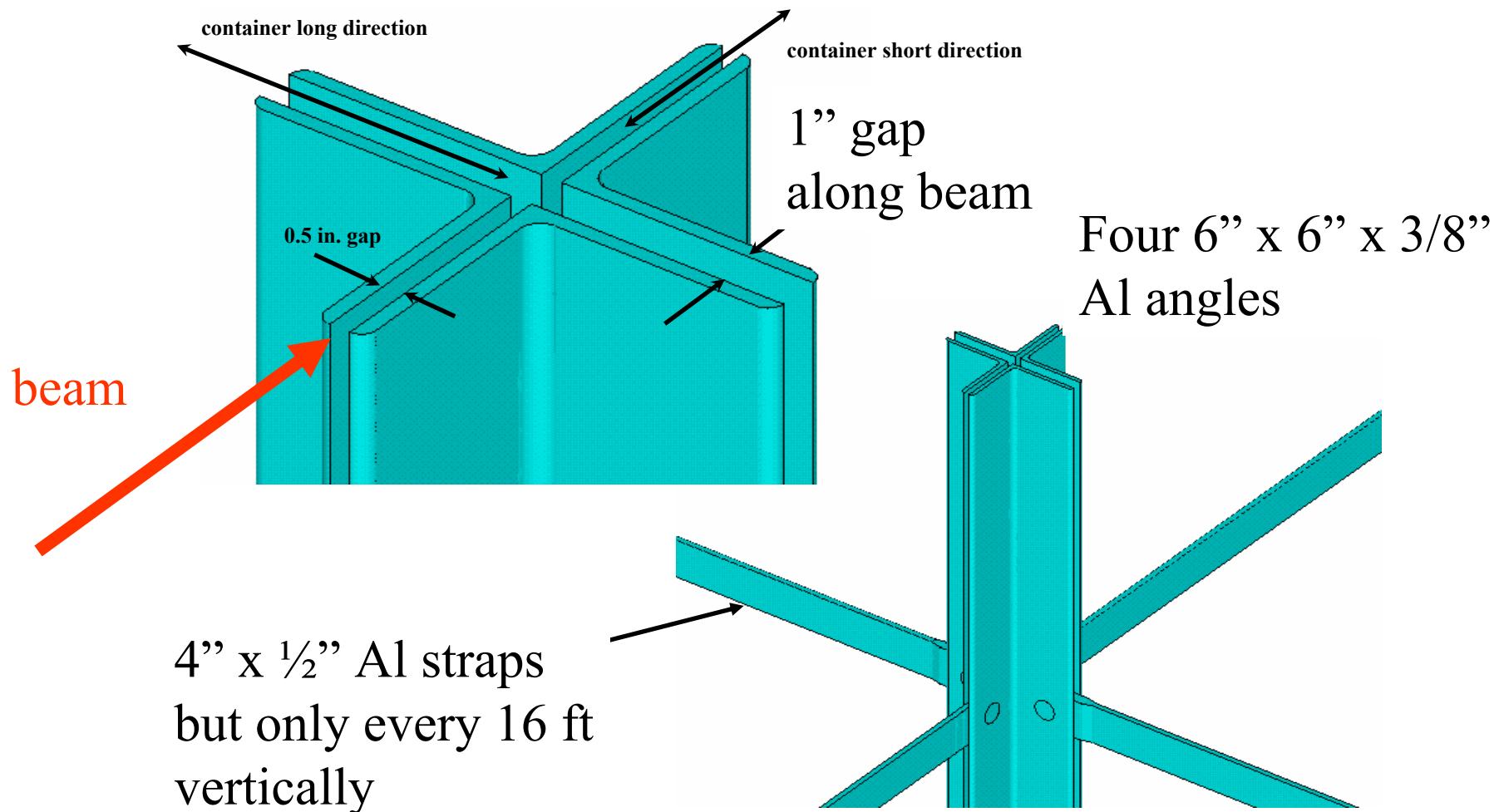
Hold about 1500 boxes.
We need 2000

They stack them
10 high



Cell guides from aluminum angle

ours can be flimsy because we don't have to withstand pitch and roll at sea



Add containers

and cables / gas lines along cell guides to tops of containers

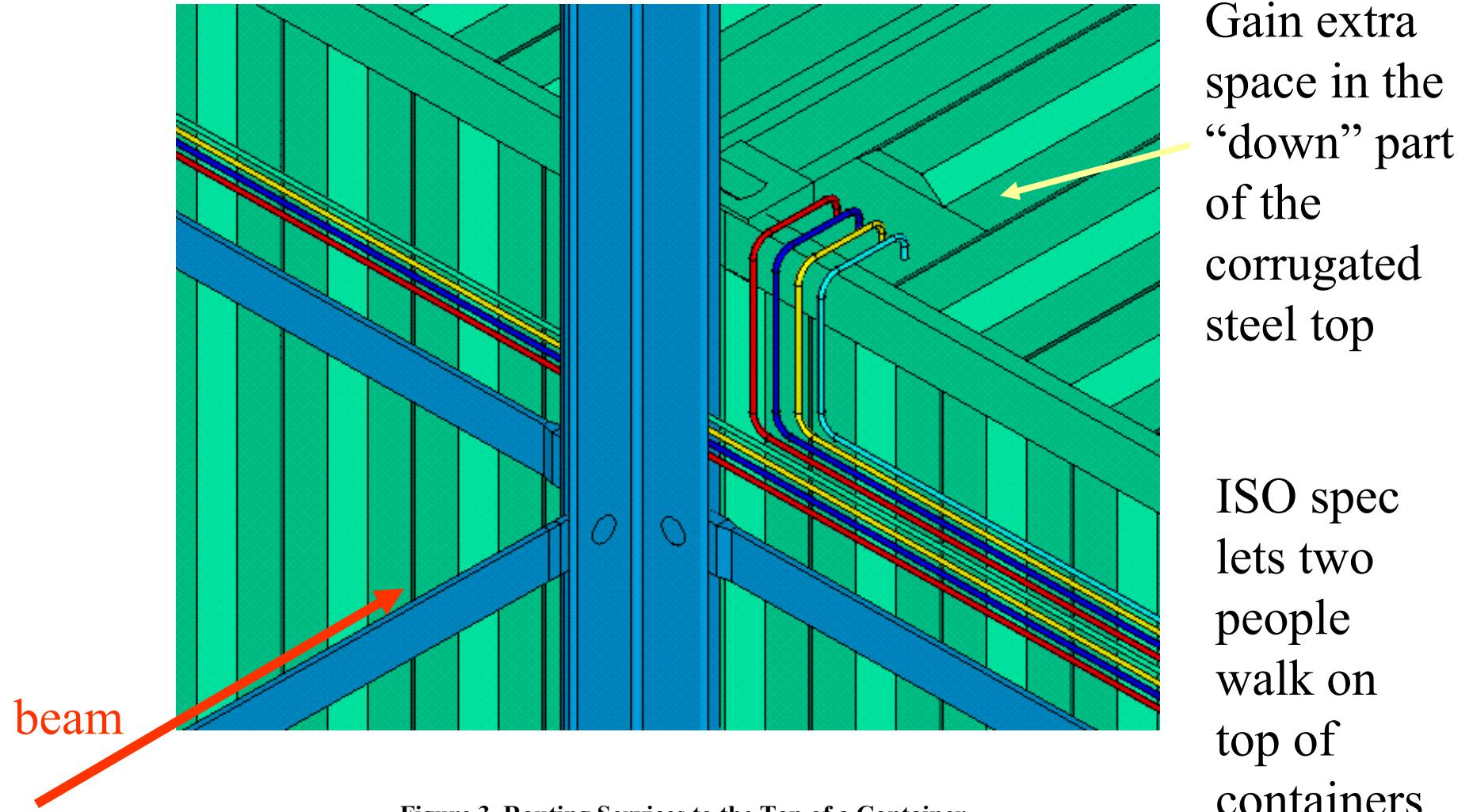
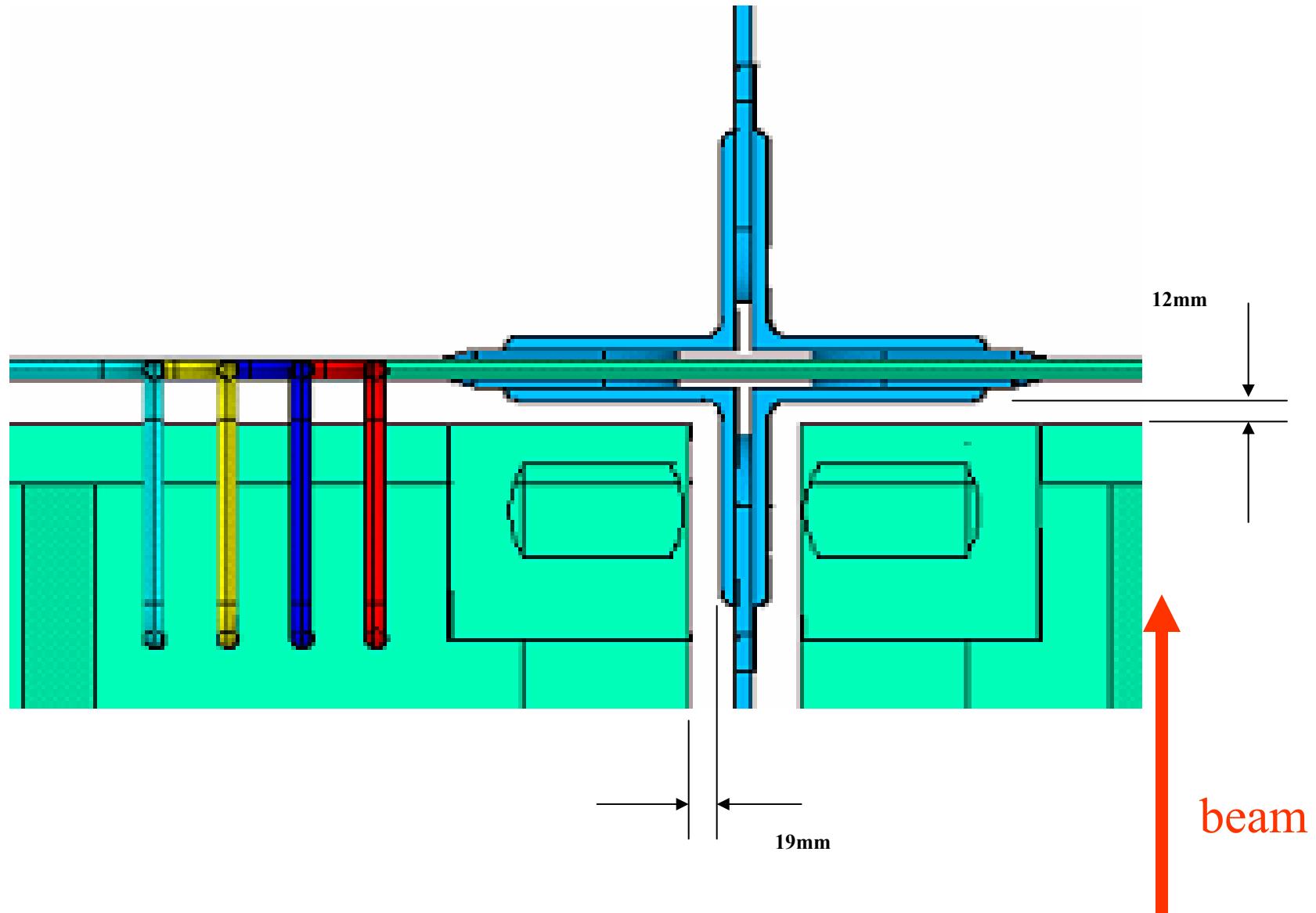


Figure 3. Routing Services to the Top of a Container

Top view of cell guides

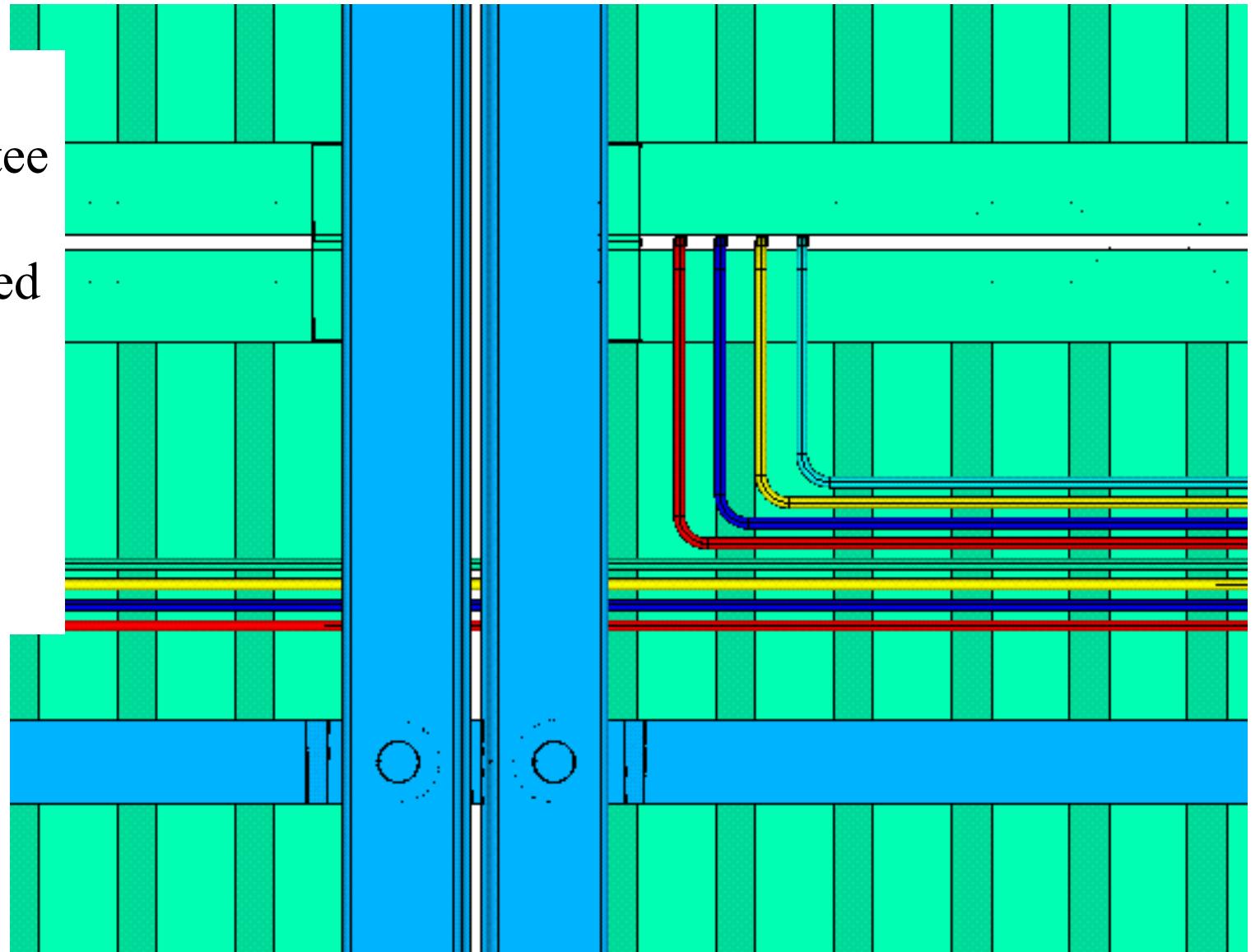


Small gap compared to the 6000 mm wide containers

Incoming beam view

The corner blocks guarantee an 18 mm gap between stacked Containers.

Use this for power, signal, gas access



Cell guides in the building

This takes 12.7 miles
of 3/8" x 6" x 6" Al angle,
but we have a quote at
\$ 1.23 / lb. = 517 K\$

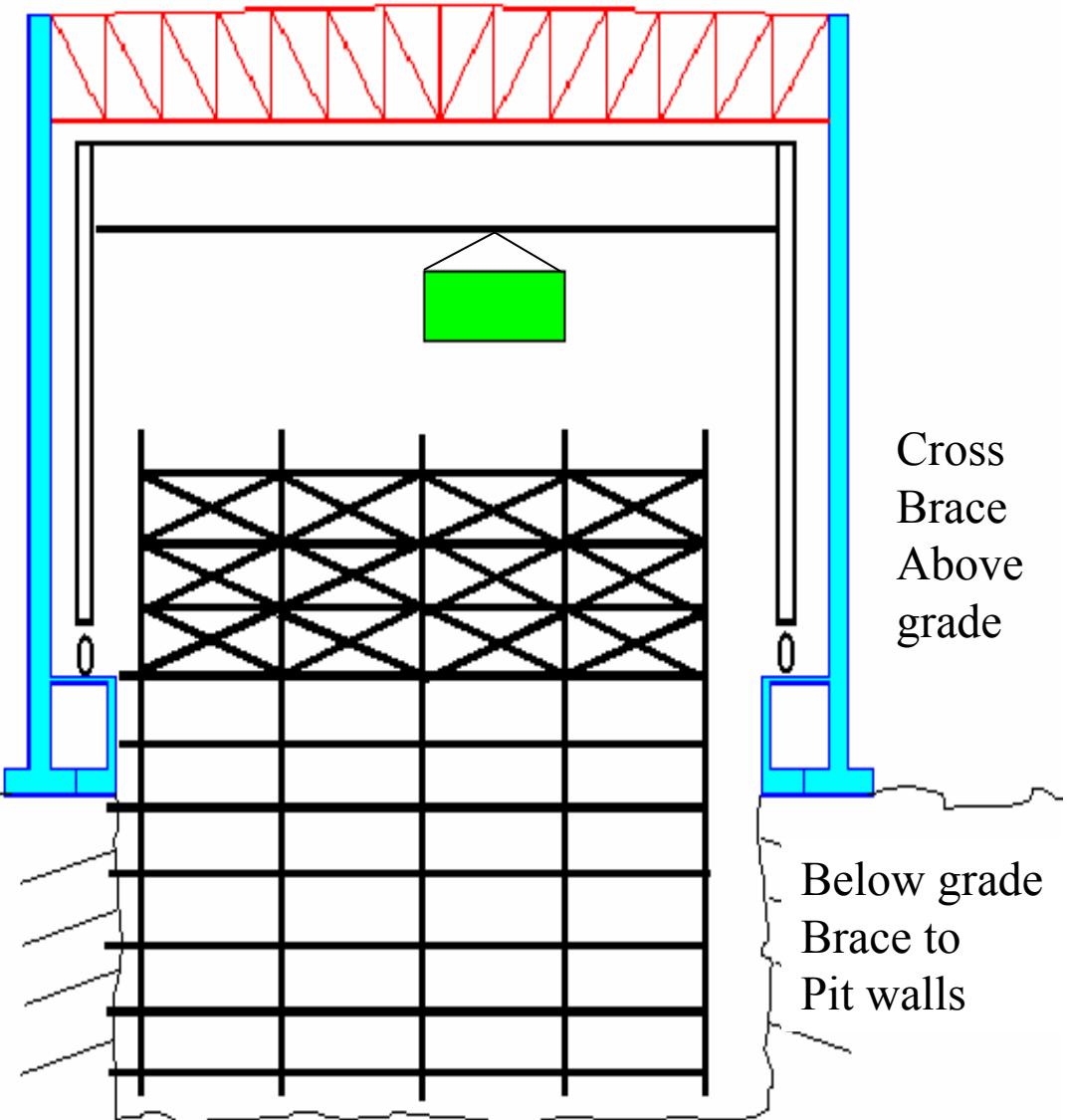
Weld subassemblies on
the ground and then erect.
A crew of 30 could build
the whole set in 20 weeks.

Total cost 1.4 M\$

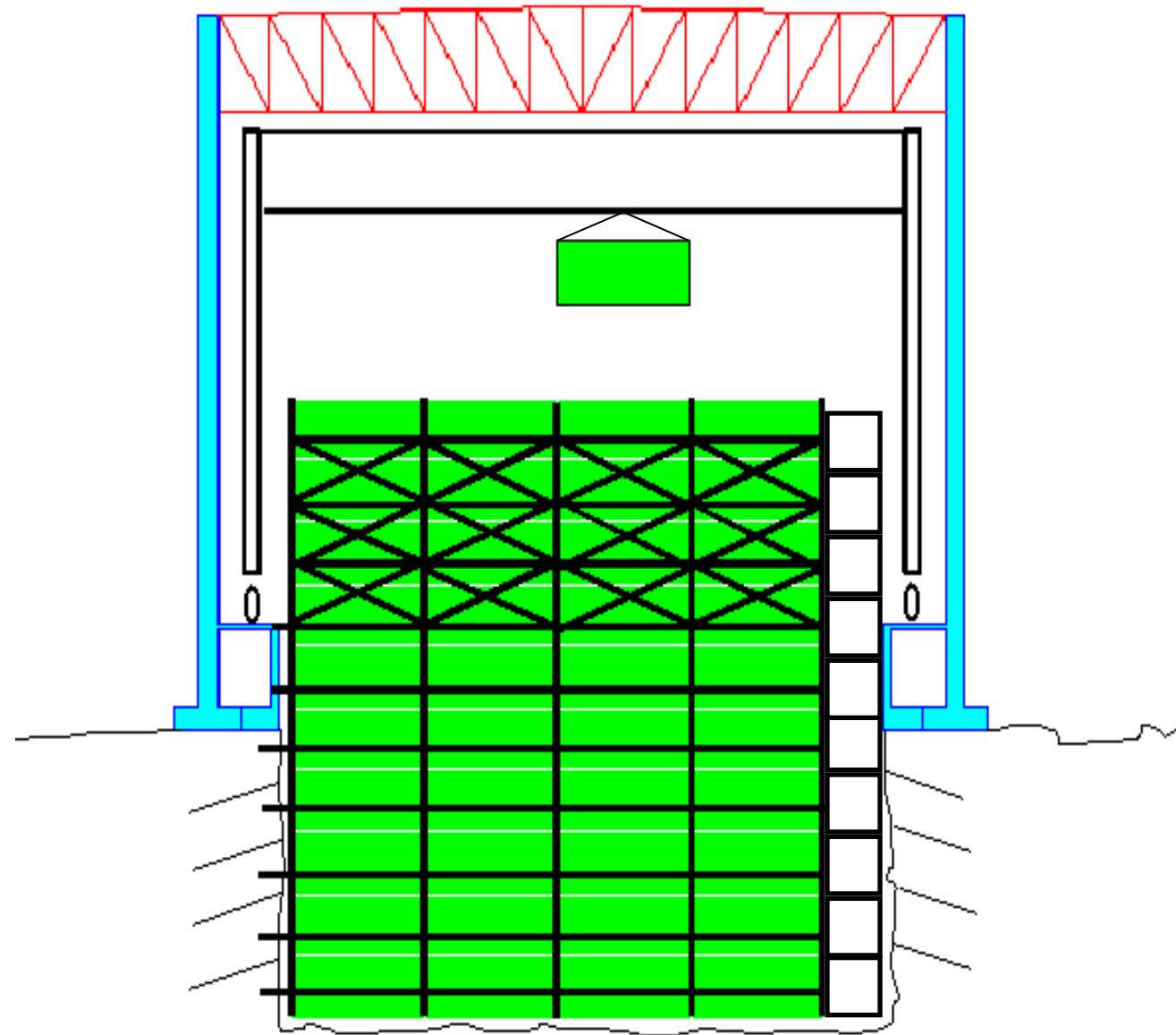
add 25% Al contingency

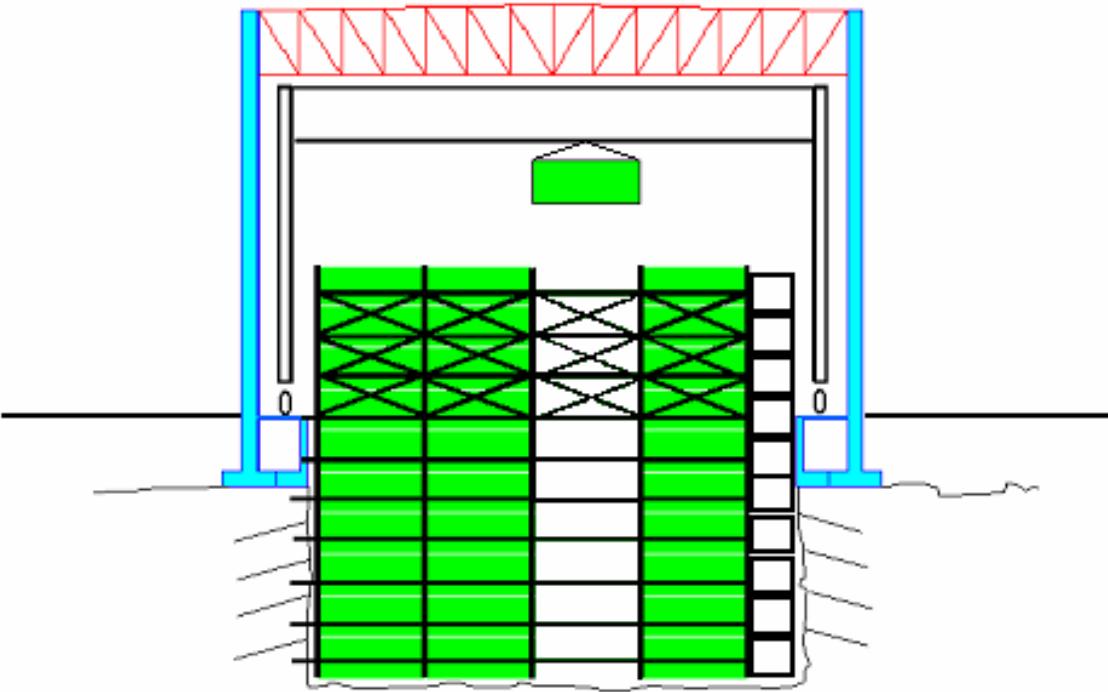
add 40% labor cont.

(steel would be cheaper,
1.1 M\$ if low Z not desired)



Full of containers

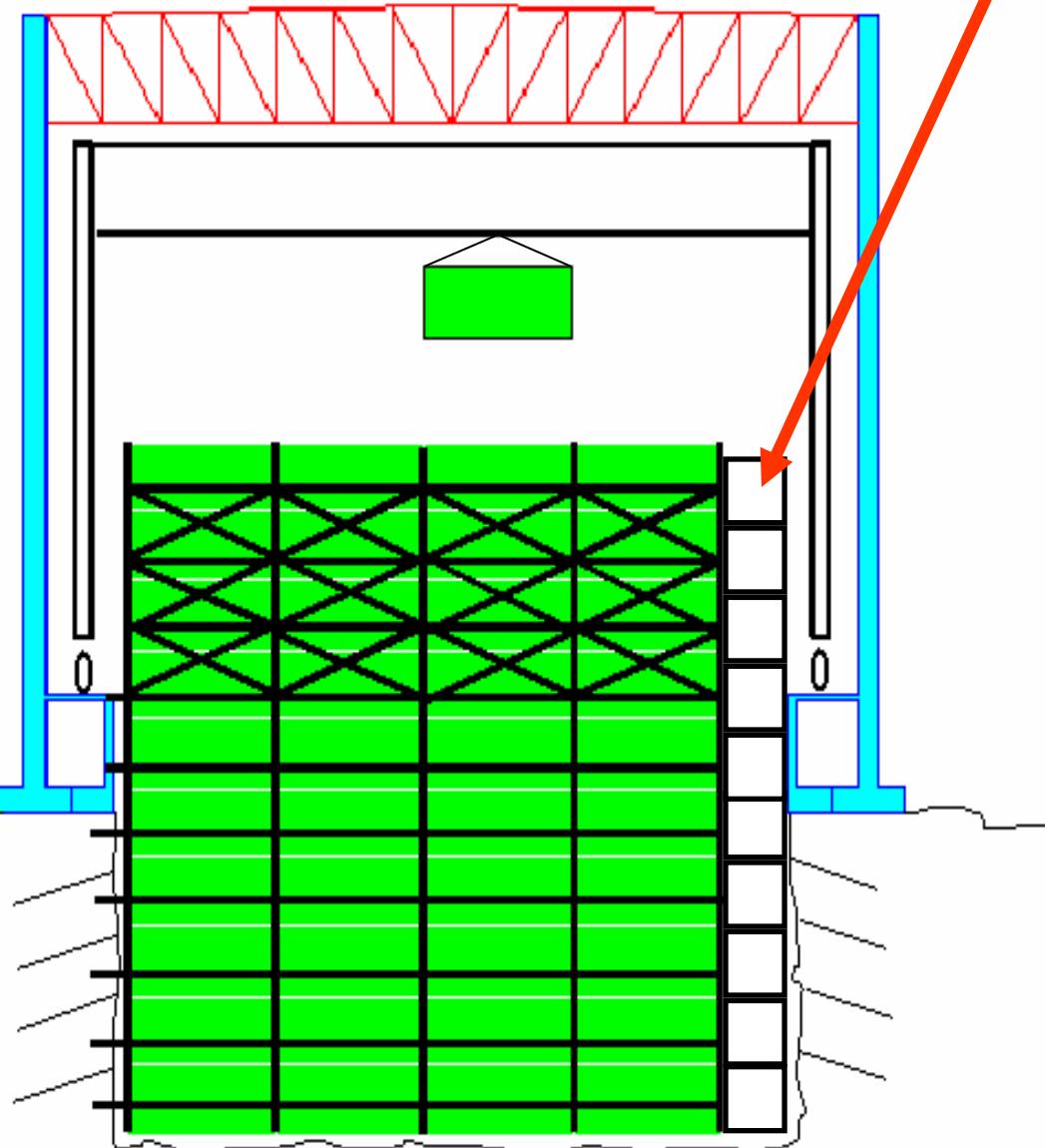




To service, just unstack

- Man hoist lowers a guy into the hole to disconnect the cables and gas,
 - lay the cables carefully up in the cell guide cable trays out of harm's way.
- RTG runs the good containers down to the staging area.
- Swap in a known “good” container to fix the problem.
- Will get engineers to calculate, but I’m guessing 2 shifts to get at and replace a bottom container.
 - Similar to CDF access Thursday to fix one drift chamber wire.

Catwalk cost



**110 40-foot containers
Turned 90 degrees to the
20-foot containers.
(have same vertical periodicity)**

Remove one door and $\frac{1}{2}$ of the opposite endwall for a 4 ft wide walkway.

Use the other 4 ft for racks.

Cut holes towards the detector array to bring out cables, gas

Tie all 110 together with twistlocks on the corner fittings

**Cost estimated at 792 K\$,
including 50% contingency**

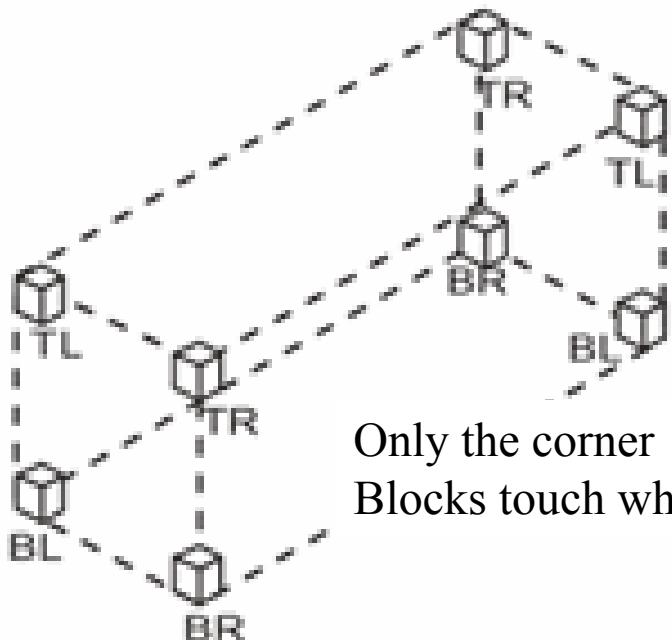
Rubber Tire Gantry (RTG) cost

- Mi-Jack quote for
 - a 30 m span, 1 above 4 RTG
 - Includes the fancy automatic lifting fixture
 - **1.8 M\$, add 20% contingency = 2.2 M\$**
 - Runs on propane
 - Might do better on a used one
- Building crane quote + beef up building columns
 - **1.4 M\$, including 25% contingency**
- Sounds cheaper, but the RTG may pay back because it can be used to muck out the excavation

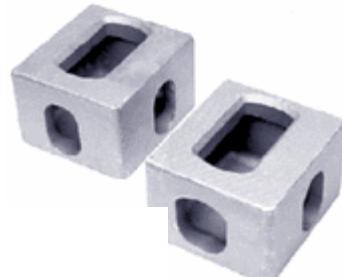
Lifting fixtures:

Off the shelf, all designed for speed

- Twistlocks lock / unlock when sling wires are slackened.
- Simple mechanical operation
- no electronics or hydraulics.
- Safer to use than manual spreaders - no ground personnel required to lock / unlock twistlocks.
- All Proof-Tested and Certified
- Painted Safety Yellow
- Warning Decals Attached
- Meets ISO 3874 and ANSI B30.20
- 4 Leg Wire Rope Sling Standard



Corner
blocks



Only the corner
Blocks touch when stacked



Twist-lock

guide

Tandemloc's
AUTOLOC
SPREADER

Also casters, box to box clamps,...

Summary

- Cell Guides used just like on container ships
 - **1.41 M\$ + 0.57 M\$ contingency** (25% Al, 50% labor)
- Catwalks built from 110 40-foot Containers
 - **0.53 M\$ + 0.26 M\$ contingency** (50%)
- RTG - Rubber Tire Gantry Crane
 - **1.80 M\$ + 0.4 M\$ contingency** (20%)
- Total “**Installation & Servicing Package**”
at 3.74 M\$ +1.23 M\$ contingency

More detail on stack height

- “standard” gross wt is 24,000 kg, 2,200 kg tare
 - 33 m³, so 0.66 gm/cc. **Corner posts tested to 86,400 kg**

# containers stacked on one	Safety factor ISO on corner post loading	Safety factor	Safety factor
	86,400 21,800+2,200	97,370 21,800+2,200	97,370 20,000+2,200
8	1.8 at sea		
9	1.6		
10	1.44	1.62	
11	1.31		1.58

26 m high
28.6 m
31.2 m

Safety Factor: 2.0 AISC Steel Construction Code (untested parts)

1.25 Aircraft Industry, rigorous testing and QA

Bob Wands likes 1.5, **since tested to 1.8**

Could be higher if we test to actual failure (>1.8)